CLAIMS

Having thus described out invention in detail, what we claim as new and desire to secure by the Letters Patent is:

1. A method for fabricating a silicon-on-insulator (SOI) substrate comprising the steps of:

(a) subjecting a Si-containing substrate to a base oxygen ion implantation step to create a first structure having a damaged implant region within the Si-containing substrate;

(b) subjecting the first structure to a room temperature oxygen ion implantation step to create a second structure having an amorphized implant region adjacent to said damaged implanted region; and

(c) performing an annealing process on said second structure, wherein at least one of steps (a)-(c) is performed under conditions that are capable of providing an SOI substrate comprising a buried oxide having a breakdown field of greater than 5 MV/cm, with the proviso that when step (a) is selected to achieve said breakdown field the base oxygen ion implantation step is performed using an oxygen ion dose of about 2.5E17 cm^{-2} or less, when step (b) is selected to achieve said breakdown field the room temperature oxygen implant step is performed at an energy that is about 5 to about 20 % less than an energy used during the base oxygen ion implantation step, or when step (c) is selected to achieve said breakdown field a pre-annealing soak cycle is employed prior to an internal oxidation step.

2. The method of Claim 1 wherein steps (b) and (c) are selected to achieve said breakdown field.

3. The method of Claim 1 wherein steps (a)-(c) are selected to achieve said breakdown field.

4. The method of Claim 1 wherein step (c) is selected to achieve said breakdown field.

5. The method of Claim 1 further comprising providing a patterned masking material or dielectric cap to said Si-containing substrate prior to performing step (a).

6. The method of Claim 5 wherein said patterned masking material or dielectric cap is removed after performing step (b) or after performing step (c).

7. The method of Claim 1 wherein the base oxygen ion implantation step is performed utilizing a single ion implantation step or multiple ion implantation steps.

8. The method of Claim 1 wherein the room temperature oxygen ion implantation step is performed utilizing a single ion implantation step or multiple ion implantation steps.

9. The method of Claim 1 wherein annealing process comprises a ramp-up anneal, an internal oxidation, annealing and a ramp-down step.

10. The method of Claim 1 wherein said annealing process forms a surface oxide on said Si-containing substrate.

11. The method of Claim 10 further comprising a step of removing said surface oxide from said Si-containing substrate by planarization or selective etching.

12. The method of Claim 1 wherein step (a) is selected to achieve said breakdown field and said oxygen ion dose is from about 2.0E17 to about 2.4E17 cm^{-2}.

13. The method of Claim 1 wherein step (a) is performed in an ion beam apparatus that operates at a beam current from about 1 to about 100 milliamps and an energy from about 1 to about 10,000 keV.

14. The method of Claim 1 wherein step (a) is performed at a substrate temperature from about 100° to about 800°C.

15. The method of Claim 1 wherein step (b) is selected to achieve said breakdown field and said energy is off-set to a value from about 6 to about 8 % lower than the energy of said base oxygen ion implantation step.

16. The method of Claim 1 wherein step (b) is selected to achieve said breakdown field and said energy is from about 155 to about 165 keV.

17. The method of Claim 1 wherein step (b) is performed using an oxygen ion dose from about 1E15 to about 5E15 cm^{-2}.

18. The method of Claim 1 wherein step (b) is performed at a temperature from about 1 Kelvin to about 200°C.

19. The method of Claim 1 wherein step (c) is selected to achieve said breakdown field and said annealing process includes a ramp-up step, said pre-annealing soak, said internal oxidation annealing, annealing and a cool-down step.

20. The method of Claim 19 wherein said pre-annealing soak is performed at a temperature of about 1250°C or greater.

21. The method of Claim 19 wherein said pre-annealing soak is performed for a time period from about 5 minutes to about 5 hours.

22. The method of Claim 19 wherein said ramp-up step, said pre-annealing soak, said annealing and said cool-down step are performed in the same or different ambient that comprises an inert gas containing less than 10% oxygen.

23. The method of Claim 19 wherein said pre-annealing soak is performed in an ambient containing greater than 30 % oxygen.

24. A method of fabricating a silicon-on-insulator substrate (SOI) comprising the steps of:

(a) subjecting a Si-containing substrate to a base oxygen ion implantation step to create a first structure having a damaged implant region within the Si-containing substrate;

(b) subjecting the first structure to a room temperature oxygen ion implantation step to create a second structure having an amorphized implant region adjacent to said damaged implanted region, wherein said room temperature oxygen implant step is performed at an energy that is about 5 to about 20 % less than an energy used during the base oxygen ion implantation step; and

(c) performing an annealing process on said second structure, wherein an SOI substrate is provided that comprises a buried oxide having a breakdown field of greater than 5 MV/cm.

25. A method for fabricating a silicon-on-insulator (SOI) substrate comprising the steps of:

(a) subjecting a Si-containing substrate to a base oxygen ion implantation step to create a first structure having a damaged implant region within the Si-containing substrate;

(b) subjecting the first structure to a room temperature oxygen ion implantation step to create a second structure having an amorphized implant region adjacent to said damaged implanted region; and

(c) performing an annealing process on said second structure, said annealing process includes a pre-annealing soak cycle employed prior to an internal oxidation step, wherein an SOI substrate is provided that comprises a buried oxide having a breakdown field of greater than 5 MV/cm.

26. A method for fabricating a silicon-on-insulator substrate comprising the steps of:

(a) subjecting a Si-containing substrate to a base oxygen ion implantation step to create a first structure having a damaged implant region within the Si-containing substrate;

(b) subjecting the first structure to a room temperature oxygen ion implantation step to create a second structure having an amorphized implant region adjacent to said damaged implanted region, said room temperature oxygen ion implantation step is performed at an energy that is about 5 to about 20 % less than an energy used during the base oxygen ion implantation step; and

(c) performing an annealing process on said second structure, said annealing process includes a pre-annealing soak cycle employed prior to an internal oxidation step, wherein an SOI substrate is provided comprises a buried oxide having a breakdown field of greater than 5 MV/cm.

27. A method for fabricating a silicon-on-insulator substrate comprising the steps of:

(a) subjecting a Si-containing substrate to a base oxygen ion implantation step to create a first structure having a damaged implant region within the Si-containing substrate, said

base oxygen ion implantation step is performed using an ion dose of about 2.5 cm^{-2} or less at an energy of 170 keV or greater;

(b) subjecting the first structure to a room temperature oxygen ion implantation step to create a second structure having an amorphized implant region adjacent to said damaged implanted region, said room temperature oxygen ion implantation step is performed at an energy that is about 5 to about 20 % less than an energy used during the base oxygen ion implantation step; and

(c) performing an annealing process on said second structure, said annealing process includes a pre-annealing soak cycle employed prior to an internal oxidation step, wherein an SOI substrate is provided comprises a buried oxide having a breakdown field of greater than 5 MV/cm.